

# BMJ Open Referral pathways for patients with TIA avoiding hospital admission: a scoping review

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## ABSTRACT

**Objective:** To identify the features and effects of a pathway for emergency assessment and referral of patients with suspected transient ischaemic attack (TIA) in order to avoid admission to hospital.

**Design:** Scoping review.

**Data sources:** PubMed, CINAHL Web of Science, Scopus.

**Study selection:** Reports of primary research on referral of patients with suspected TIA directly to specialist outpatient services.

**Data extraction:** We screened studies for eligibility and extracted data from relevant studies. Data were analysed to describe setting, assessment and referral processes, treatment, implementation and outcomes.

**Results:** 8 international studies were identified, mostly cohort designs. 4 pathways were used by family doctors and 3 pathways by emergency department physicians. No pathways used by paramedics were found. Referrals were made to specialist clinic either directly or via a 24-hour helpline. Practitioners identified TIA symptoms and risk of further events using a checklist including the ABCD2 tool or clinical assessment. Antiplatelet medication was often given, usually aspirin unless contraindicated. Some patients underwent tests before referral and discharge. 5 studies reported reduced incident of stroke at 90 days, from 6–10% predicted rate to 1.3–2.1% actual rate. Between 44% and 83% of suspected TIA cases in these studies were referred through the pathways.

**Conclusions:** Research literature has focused on assessment and referral by family doctors and ED physicians to reduce hospitalisation of patients with TIA. No pathways for paramedical use were reported. We will use results of this scoping review to inform development of a paramedical referral pathway to be tested in a feasibility trial.

**Trial registration number:** ISRCTN85516498. Stage: pre-results.

## INTRODUCTION

Transient ischaemic attack (TIA) is a neurological event characterised by the resolution

## Strengths and limitations of this study

- This is the first attempt to systematically search and describe referral pathways for patients with transient ischaemic attack (TIA) to gain timely access to appropriate specialist assessment, thereby avoiding hospital admission.
- We followed a systematic approach based on guidance for carrying out a scoping review and reported our methods fully: that our research team included paramedics, ambulance service managers, nurses, stroke clinicians and patients alongside experienced trialists, provided a broad and complementary range of perspectives to implement our review and interpret findings.
- We balanced resources and timescales against need to inform intervention development in our feasibility study; we discussed methods and findings within the study team to assess and monitor processes.
- We did not assess the reporting quality of papers. However, all were published in international peer-reviewed journals and we have reported study results to aid interpretation, in line with recommendations.
- Our findings, which suggest there is potential for paramedics who are often the first healthcare professionals to attend, assess and refer suspected TIA cases, will be used to inform development of an intervention for paramedics to be tested in a feasibility trial.

of focal and non-focal symptoms within 24 hours and with limited associated sequelae.<sup>1</sup> Clinical studies have demonstrated that patients who have a TIA are at risk of further TIAs, stroke and death.<sup>2–5</sup> Delays in the processes of care for TIA have consequences for the health and satisfaction of patients. Inefficiencies in provision of care may increase the burden on health services, particularly emergency and secondary care.<sup>6</sup> In the UK, stroke has a direct cost to the National Health Service (NHS) of £2.8 billion

per year; informal care costs of £2.4 billion per year and costs the economy £1.8 billion per year.<sup>7</sup>

TIA's are not always regarded as emergencies since the stroke-like symptoms present and resolve in a short time without treatment. Symptoms may therefore be ignored or disregarded by patients, their families and even by first contact clinicians.<sup>5 8–10</sup> Risk of stroke following a TIA can be assessed using the ABCD2 tool which considers age, blood pressure, clinical features of TIA, duration and presence of diabetes in a 0–7 scoring system.<sup>11</sup> Patients with low-risk TIA are diagnosed as having an ABCD2 score of 0–3 which is associated with a 1% risk of stroke within the following 2 days. Higher ABCD2 scores (4–5 or 6–7) are associated with greater risk of stroke during the following 2, 7, 30 and 90 days after a TIA.<sup>11</sup> In the UK, the National Institute for Health and Care Excellence (NICE) recommends that low-risk patients with TIA are assessed by a specialist within 1 week, and that high-risk patients with TIA are assessed by a specialist within 24 hours.<sup>12</sup> Many patients present with suspected TIA to the emergency ambulance service and then encounter delays in hospital before being seen by a stroke or TIA specialist.<sup>13</sup>

Treatment of TIA has been identified as one of the conditions potentially able to receive an alternative response to traditional conveyance by ambulance to hospital.<sup>14</sup> Low-risk patients with TIA can be managed safely and effectively as outpatients, without hospital-based treatment.<sup>15 16</sup> However, risk of hospitalisation for a patient with TIA increases with emergency department (ED) overcrowding, suggesting clinicians' decision-making is affected by the pressured environment.<sup>17</sup> As the role of ambulance services in the UK and internationally has shifted, from predominantly assessment and transport to hospital to clinical assessment and decision-making on scene, ambulance services are exploring alternative care pathways for appropriate low-risk patients, to refer direct to relevant specialist services (eg, mental health services, diabetes specialist) or leave patients at home.<sup>18–27</sup> Increased demand for emergency and prehospital care has been highlighted by the media on numerous occasions.<sup>28–30</sup> Paramedics routinely identify and assess patients who suffered stroke before transporting direct to stroke centres.<sup>14</sup> Some ambulance services are now setting up alternative pathways for presumed low-risk suspected TIA with protocols for direct referral to specialist services, avoiding the ED. Recent guidelines recommend paramedics use a validated tool to identify patients' risk of further TIA or stroke and safely refer to specialist TIA services.<sup>14 31</sup> However, the ABCD2 tool has not yet been validated in a prehospital context and the evidence is inconclusive about how best to assess risk in this patient group and safely make referrals along appropriate clinical pathways,<sup>31–34</sup> new knowledge about safety, effectiveness and costs of this new model of care is therefore limited.<sup>14 35</sup>

The Welsh Ambulance Service NHS Trust and PRIME Centre Wales received funding to assess the feasibility of

assessment and referral of patients with low-risk TIA by paramedics directly to TIA clinic rather than conveyance to the ED. The TIER (Transient Ischaemic Attack 999 Emergency Referral) study is designed to test whether this intervention is acceptable and whether study design, recruitment and data collection are achievable in order to plan a fully powered randomised trial if preset progression criteria are met.<sup>36</sup> Our protocol is available from the authors. We have obtained ethical approval and begun recruitment. Potential benefits of the new pathway include timely specialist review for patients with low acuity TIA without: adverse consequences; the inconvenience of ED attendance; and unnecessary cost to the NHS.

To inform development of an ambulance paramedic referral for TIA, we conducted a scoping review of the literature to identify existing prehospital emergency pathways and evidence about their implementation and effectiveness. Scoping reviews are suitable for undertaking rapid mapping of the literature in areas where little previous investigation has been undertaken<sup>37 38</sup> and can inform further research and practice.<sup>37–45</sup> They are concerned with 'contextualizing knowledge...and then setting this within policy and practice contexts' (p. 10).<sup>39</sup>

The objective of this review is to identify the features and effects of a pathway for emergency assessment and referral of patients with suspected TIA in order to avoid admission to hospital and gain timely access to appropriate outpatient-based specialist assessment.

## METHODS

We followed guidance for undertaking a rapid scoping review,<sup>38 46</sup> while noting that specific advice for scoping reviews is not available<sup>45</sup> (see also <http://www.equator-network.org/>).

## Eligibility criteria

We included studies reporting descriptive and effectiveness data about assessment and referral pathways for patients with TIA directly referred to specialist services, avoiding hospital admission. We excluded studies where patients were admitted to a designated observation unit or stroke centre or who were treated in the ED without receiving an outpatient referral because these treatment routes did not incorporate referral to avoid admission to a secondary care centre. We also excluded studies which did not report enough information to allow us to replicate the pathway. In line with advice to search widely across the literature,<sup>37 41</sup> we sought any study method. Our inclusion and exclusion criteria are shown in table 1.

## Information sources and search strategy

We searched four electronic databases (PubMed, CINAHL, Web of Science and Scopus). We tested and revised our search strategy to focus on TIAs and the

**Table 1** Inclusion and exclusion criteria for studies included in the scoping review

|              | Inclusion criteria   | Exclusion criteria   |
|--------------|--|--|
| Population   | Patients presenting with suspected TIA   | Patients presenting with ongoing symptoms suggestive of stroke<br>Patients presenting with recurrent or crescendo focal neurological symptoms  |
| Intervention | Assessment, referral and treatment for suspected TIA in order to avoid admission to hospital<br>Intervention described in enough detail to be replicable<br>Attendance at ED as part of a referral pathway to avoid hospital admission | Admission to hospital<br>Admission to a designated observation ward or unit<br>ED treatment without a referral pathway<br>Lack of information about assessment, treatment or referral criteria and processes |
| Comparator   | Any study design: no comparator necessary  | Editorial, opinion and discussion pieces   |
| Outcomes     | Outcomes not necessary   |  |
| Study design | Any study design<br>English language<br>Published 2005–2015  |  |

ED, emergency department; TIA, transient ischaemic attack.

prehospital setting after initial searches, which included the terms ‘mini-stroke’, ‘stroke’, ‘pathway’, ‘care’ and ‘treatment’ identified the literature on stroke treatment, care pathways and guidelines rather than TIAs.<sup>38</sup> Our research team discussed results of early scoping searches allowing us to clarify the features of a referral pathway (eg, from any community or prehospital route) and patient group (eg, patients no longer displaying TIA symptoms).<sup>44 47</sup> In this way, we combined a broad question with a clearly articulated scope of enquiry.<sup>40</sup> Our final search strategy included the following search terms:

(TIA OR Transient Ischaemic Attack OR Transient ischemic attack) AND (999 OR prehospital OR pre-hospital OR ambulance OR ambulances OR ambulance\* OR paramedic\* OR emergency).

We used MeSH headings and key words where possible. We carried out our searches in January and February, 2016. We limited searches to English language reports published between 2005 and 2015.

### Study selection

Two authors (BAE and MJ) undertook a two-stage screening process against inclusion criteria for selection of studies identified through electronic searches: (1) screening by title and abstract to identify potentially eligible studies; and (2) assessing full papers to confirm those suitable for inclusion in this review. Differences were resolved in discussion, with a third reviewer (ACS) available to mediate if required.

### Data extraction, presentation and reporting

We extracted data on a predefined table. We adapted this from the Cochrane Collaboration Handbook<sup>48</sup> to ensure our review approach retained systematic and clear standards of reporting. We presented results according to PRISMA guidance<sup>49</sup> using a flow chart, table and narrative summaries to chart key items of

information.<sup>50</sup> Data extraction was undertaken by BAE and JB.

### Quality assessment

We did not assess the quality of evidence reported by papers included in our scoping review. Arksey and O'Malley<sup>38</sup> state that scoping reviews should not present the ‘weight’ (p. 18) of evidence, which they define as robustness or generalisability, by assessing the quality of reporting by included papers. However, we sought to clearly report study findings so that the reader can determine potential bias in this paper's findings and discussion.<sup>38</sup>

## RESULTS

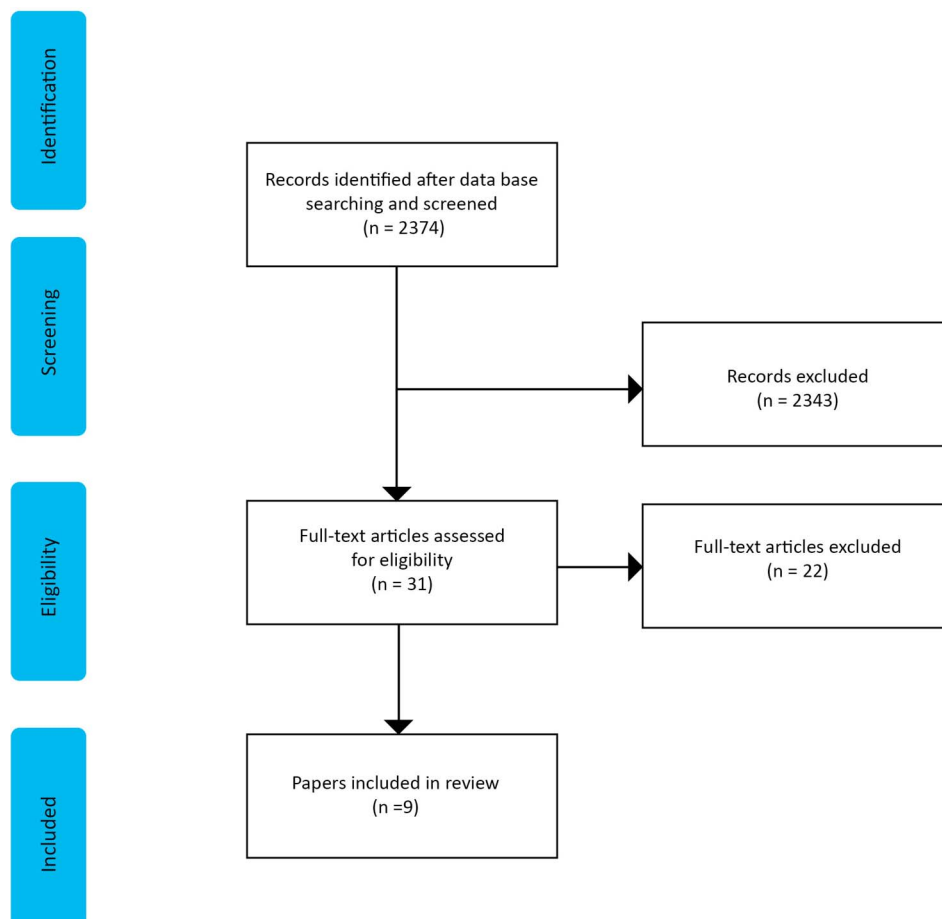
### Characteristics

Of the 2374 references reviewed, 31 full papers were obtained and 9 papers reporting 8 studies met our inclusion criteria (see figure 1). Characteristics of included studies are reported in table 2. Two papers each reported studies undertaken in the UK,<sup>6 51</sup> France<sup>52 53</sup> and Australia<sup>54 55</sup> and one in Canada.<sup>56</sup> Two papers reported the protocol<sup>57</sup> and results<sup>58</sup> of a study undertaken in New Zealand. One randomised controlled trial was identified;<sup>58</sup> other studies incorporated a control group, either using a before and after<sup>6 51 53</sup> or cohort design.<sup>53 55 57</sup> Two papers<sup>56 57</sup> presented a study with no results included. Number of patients ranged from 185 to 1085. Data collection periods ranged from 3 to 36 months. All papers were published in international peer-reviewed journals reporting general medical, stroke or neurological studies.

### Referral and treatment pathway

Three studies described a referral pathway initiated in the ED by physicians when presented with a patient with suspected TIA.<sup>53–55</sup> Patients were assessed against

Figure 1 Search results.



predefined criteria,<sup>54</sup> a checklist<sup>55</sup> or algorithm<sup>52</sup> and then referred to a specialist clinic instead of being admitted for evaluation at the ED. Appointment arrangements varied between referral models. In the Monash TIA Triaging Treatment (M3T) pathway,<sup>54</sup> a stroke registrar and nurse triaged new referrals and made appointments according to priority. Appointments reflected clinical need in the Griffiths *et al*<sup>55</sup> study also and could be provided the same day if clinically required<sup>54 55</sup> or within 4–6 weeks if antiplatelet treatment had been initiated.<sup>54</sup> However, Montassier *et al*<sup>53</sup> reported that appointments were made for 8–15 days after referral. In the Griffiths *et al*<sup>55</sup> study, patients received an education pack with instructions to follow-up with the general practitioner and call an ambulance if symptoms recurred.

The five other studies described a referral pathway which was initiated by the family doctor when a patient presented to them. In three studies, the doctor used a checklist (ABCD2 or one provided for the study) to identify patients with suspected low-risk TIA. The doctor then called a consultant-led 24-hour telephone hotline<sup>51 52 56</sup> to gain specialist advice and referral to stroke treatment service according to symptom severity and urgency. The doctor was able to discuss symptoms and severity with the specialist staff and agree whether referral was required and how soon the patient should

be seen if an appointment was agreed to be necessary.<sup>51 56</sup> In the fourth study,<sup>6</sup> the doctor directly referred patients with suspected TIA to a daily specialist clinic where no appointment was required. The clinic then confirmed the doctor's diagnosis and arranged for treatment to begin. Rothwell *et al*<sup>6</sup> and Lavallée *et al*<sup>52</sup> reported that clinic treatment reports and advice were sent to the patient's family doctor detailing blood tests, brain scans and prescribed medication for hypertension and anticoagulation to reduce risk of further TIAs. Family practitioners were advised of the new referral services through letters and leaflets which included information about risks, diagnosis and management of stroke and TIAs. Ranta *et al*<sup>57</sup> described an online decision support tool accessed by family doctors through a menu button situated on the navigation bar of their practice management software. This provided a single page of tick boxes concerning relevant aspects of presenting illness history and a brief focused physical examination. The software automatically populated fields for relevant medical history (such as diabetes and smoking) from the practice management system. Using inputted data, the software confirmed or rejected TIA or stroke as the likely diagnosis. If confirmed, it generated a triage option based on the ABCD2 score supplemented by variables from the New Zealand TIA guidelines. For low-risk patients, general practitioners (GPs) were given two



**Table 2** Characteristics of included studies

| Reference  | Country                    | Method   | Sample size   | Period of data collection                                     |
|--|----------------------------|--|---|---|
| Sanders <i>et al</i> <sup>54</sup>                                   | Victoria, Australia        | Prospective before and after study   | Before intervention: 169 patients<br>After intervention: 301 confirmed TIA cases  | Before: 12 months (2003–2004)<br>After: 36 months (2004–2007) |
| Montassier <i>et al</i> <sup>53</sup>                                | Nantes, France             | Prospective cohort study   | 118 patients  | 12 months<br>January to December 2009                         |
| Griffiths <i>et al</i> <sup>55</sup>                                 | New South Wales, Australia | Prospective cohort study   | 200 patients  | 22 months<br>October 2008 to July 2010                        |
| Lavallee <i>et al</i> <sup>52</sup>                                  | Paris, France              | Prospective cohort study   | 1085 patients   | 24 months<br>January 2003 to December 2005                    |
| Rothwell <i>et al</i> <sup>6</sup>                                   | Oxfordshire, England       | Prospective before and after study nested within a population-based incidence study of all TIA and stroke (OXVASC study) | 644 patients presented with TIA or stroke<br>281 referred for outpatient assessment using EXPRESS treatment protocol  | 30 months<br>1 October 2004 to 31 March 2007                  |
| Kerr <i>et al</i> <sup>51</sup>                                      | Lothian, Scotland          | Audit of telephone hotline and referral within prospective before and after study of reconfigured stroke service         | 376 calls to hotline  | 3 months  |
| Jeerakathil <i>et al</i> <sup>56</sup>                               | Alberta, Canada            | Algorithm and hotline pathway developed through consensus process. Reported in protocol for before and after study       | Study protocol  | 15-month implementation period                                |
| Ranta <i>et al</i> <sup>57</sup><br>Ranta <i>et al</i> <sup>58</sup> | New Zealand                | Cluster randomised controlled trial  | Study protocol <sup>57</sup><br>Results <sup>58</sup><br>56 general practices (29 intervention)<br>172 intervention group patients<br>119 intervention group patients | 13.5 months<br>24 February 2012 to 15 May 2013                |

TIA, transient ischaemic attack.

options. The first was to refer to outpatient TIA clinic using an automatically generated referral form. This contained all the information needed by a specialist to prioritise patients appropriately. Or the doctor could chose to manage the patient in the community following a step-by-step process covering prescriptions, radiology referral and information forms to give to the patient.

Studies reported a wide range of criteria to include and exclude patients (see [table 3](#)). Jeerakathil *et al*<sup>56</sup> and Griffiths *et al*<sup>55</sup> used the ABCD2 scores to identify patients with suspected low-risk TIA. The decision support system described by Ranta *et al*<sup>57</sup> used ABCD2 scores supplemented by other variables taken from the New Zealand TIA guidelines. Kerr *et al*<sup>51</sup> and Montassier *et al*<sup>53</sup> reported that doctors used an algorithm which considered time since symptom onset, symptoms experienced, extent of recovery and presence of atrial fibrillation. ED physicians in the Sanders *et al*<sup>54</sup> study applied the International Classification of Diseases (ICD)10 Australian Modification TIA code G45.8 or G45.9 while family doctors in the Lavallee *et al*<sup>52</sup> study made their

assessments based on clinical expertise. Rothwell *et al*<sup>6</sup> did not specify how family doctors assessed TIA.

Common features of pathways included the following:

- ▶ Suspected TIA diagnosis and risk assessment were made using a symptom-based algorithm or the ABCD2 score;
- ▶ Low-risk patients with suspected TIA, suitable for the referral pathway, had an ABCD2 score <4 (where stated);
- ▶ Patients could be referred to clinic without appointment, via a central contact point or electronic system which led to arrangements for attendance during the next 2 weeks;
- ▶ Antiplatelet therapy, generally aspirin unless contraindicated, was prescribed before discharge;
- ▶ Patients received comprehensive tests and further treatment at outpatient clinic (such as blood tests, brain scans, medication for hypertension and anticoagulation).

Further details about the referral and treatment pathways are provided in [table 3](#).

**Table 3** Referral and treatment pathways for patients with suspected TIA

| Study                                 | Setting and intervention   | Assessment and recognition of TIA  | Criteria for referral pathway (inclusion/exclusion criteria)   | Referral process  | Management or treatment   |
|---------------------------------------|--|--|--|---|---|
| Sanders <i>et al</i> <sup>64</sup>    | ED<br>Triage based on clinical expertise in consultation with stroke team; referral to stroke clinic (priority or 4–6 weeks)     | ED physician assesses patient for TIA. Diagnosis confirmed by stroke neurologist after clinical consultation.<br>All patients were assigned ICD10 Australian Modification TIA code G45.8 or G45.9.   | Definition of TIA for diagnosis into M3T pathway: ‘acute loss of focal cerebral or monocular function with symptoms lasting <24 hours and thought to be due to inadequate cerebral or ocular blood supply as a result of arterial thrombosis or embolism’. | ED physician faxes standardised TIA referral to daily TIA clinic to facilitate outpatient review. Stroke registrar and nurse triage referrals daily with priority appointments for ipsilateral internal carotid artery stenosis $\geq 50\%$ ; confirmed symptomatic stenosis $\geq 70\%$ ; AF. Other patients seen within 4–6 weeks if antiplatelet therapy is started in ED. | M3T treatment pathway:<br>1. Emergency physician evaluation of patient in consultation with stroke team<br>2. Urgent CT brain imaging, ECG and baseline blood tests (forms marked TIA pathway to expedite)<br>3. Antiplatelet therapy/warfarin/ antihypertensive therapies/ lipid-lowering therapies (depending on test results)                                  |
| Montassier <i>et al</i> <sup>63</sup> | ED<br>Triage based on decision algorithm; referral to stroke clinic (8–15 days)  | ED physician uses decision algorithm: yes/no answers<br>Total recovery of symptoms<br>Normal physical examination<br>Normal blood tests results (white cell counts and platelet counts, red blood cells, glucose, ionogram and creatinine)<br>ECG negative for AF<br>Cranial CT negative for bleeding or other diagnosis | All yes=discharge to outpatient TIA evaluation<br>One no=admit patient   | All discharged patients were managed as outpatients in 8–15 days<br>Antiplatelet therapy started before discharge.  | At outpatient clinic (8–15 days later), all received extracranial Doppler testing of supra aortic arteries and vascular neurology consultation  |
| Griffiths <i>et al</i> <sup>65</sup>  | ED<br>Triage based on ABCD2 checklist; referral for neurological review and stroke clinic (timings based on risk stratification) | ED physician uses ABCD2 checklist to identify TIA and risk status  | Exclusion:<br>ABCD2 scores $\geq 4$ or high-risk features (neurologist contacted)<br>Inclusion:<br>score <4 and no high-risk features (including known carotid disease, AF, crescendo TIA)   | Fax request by departmental secretary for expedited neurologist review.<br>Refer patients to outpatient CT angiography or carotid ultrasound and request echocardiogram and Holter monitor scan to exclude patients with haemorrhage<br>Initiate antiplatelet therapy if not already on warfarin  | After neurologist review, patients with ABCD2 scores $\geq 4$ could be discharged. Patients provided with patient education pack with instructions:<br>How to start aspirin and aspirin/ dipyridamole<br>Follow-up with GP within 7 days<br>Call ambulance if symptoms recur.<br>Departmental secretary contacts patient and arranges follow-up with neurologist. |

Continued

**Table 3** Continued

| Study                               | Setting and intervention  | Assessment and recognition of TIA  | Criteria for referral pathway (inclusion/exclusion criteria)  | Referral process   | Management or treatment   |
|-------------------------------------|---|--|---|--|---|
| Lavallée <i>et al</i> <sup>62</sup> | Primary care<br>Triage based on clinical expertise with access to 24-hour consultant-led hotline and outpatient stroke clinic | Family doctor identifies TIA   | Focal symptoms of brain or retinal dysfunction<br>Sudden onset and presumed to be related to ischaemia<br>Patients had subsequently made total recovery | Family doctor calls 24-hour hotline if suspects TIA<br>Family doctor phone call triaged as TIA by stroke nurse (0900–1700) or senior vascular neurologist (1700–0900)=patient attends clinic | <ol style="list-style-type: none"> <li>1. Assessment within 4 hours of admissionClinical assessment by vascular neurologist</li> <li>2. Tests: MRI or CT brain imaging; ultrasonography and transcranial Doppler imaging; electrocardiography; blood tests for lipid profile, iconography, red and white cell count and platelet count, glucose, haemoglobin A, C reactive protein, creatinine</li> <li>3. Vascular neurologist discusses case with referral doctor. Patient identified for discharge (unless admission criteria met)</li> <li>4. Prevention therapy targets sent to family doctor (blood pressure, LDL cholesterol, aspirin administration, smoking status and treatment started if possible)</li> <li>5. Antithrombotic treatment started</li> <li>6. Patients given anticoagulant, antiplatelet or carotid revascularisation as appropriate</li> <li>7. Discharge</li> </ol> |
| Rothwell <i>et al</i> <sup>6</sup>  | Primary care<br>Direct GP referral to daily TIA clinic  | GP identifies suspected TIA. No details provided of assessment or recognition process. | No details provided   | GP directly refers patients with suspected TIA to daily afternoon TIA/minor stroke clinic (no appointment necessary)   | Stroke clinic confirms diagnosis and begin treatment:<br>Aspirin or clopidogrel<br>Simvastatin<br>Blood pressure lowering<br>Anticoagulation<br>4-week prescription provided for all medication<br>CT brain scan obtained for patients with incomplete resolution of symptoms at time of assessment<br>Report of assessment, investigations and treatment faxed to GP within 24 hours   |

Continued

Table 3 Continued

| Study                                  | Setting and intervention   | Assessment and recognition of TIA   | Criteria for referral pathway (inclusion/exclusion criteria)  | Referral process  | Management or treatment  |
|--|--|---|---|---|--|
| Kerr <i>et al</i> <sup>61</sup>        | Primary care<br>Triage algorithm with access to 24-hour consultant-led hotline and outpatient stroke clinic (additional appointment slots created for pathway) | Algorithm provided to GPs:<br>1. Does patient have focal neurological deficits?<br>2. Are symptoms still present?<br>3. Did symptoms come on rapidly?<br>4. Did symptoms start within past 4 hours?<br>5. Did symptoms start while patient was awake? | Answers to five algorithm questions: All yes, ring 999: may need thrombolysis<br>q2 yes, q4 or q5 no: discuss with stroke consultant today: ring bed bureau or hotline<br>q2 no: ring stroke line, patient seen within 7 days<br>q1 no: unlikely TIA, refer to another service  | Options for GP/consultant in discussion via telephone helpline:<br>Appointment time for GP to immediately give patient<br>Go to ED<br>Call 999<br>Refer patient to appropriate service<br>Advice but agree no further secondary assessment needed   | No details provided  |
| Jeerakathil <i>et al</i> <sup>66</sup> | Primary care<br>Triage algorithm with access to 24-hour consultant-led hotline and outpatient stroke clinic  | Triage algorithm for primary care physicians when viewing patients with suspected TIA or stroke to assess risk—high, medium or low  | High-risk: (1) symptom onset within past 48 hours with any of the following—motor deficit lasting more than 5 min; speech deficit lasting more than 5 min; ABCD2 score $\geq 4$ ;<br>(2) atrial fibrillation with TIA.<br>Medium risk: (1) symptom onset between 48 hours and 7 days with any of the following—motor deficit lasting more than 5 min; speech deficit lasting more than 5 min; ABCD2 score $\geq 4$ .<br>Low-risk: (1) symptom onset $\geq 7$ days; (2) symptom onset $\leq 7$ days without the presence of high-risk symptoms.<br>Unsure: physician contact 24 stroke hotline for immediate access to stroke specialist | High-risk: physician contacts 24 hour hotline for immediate access to stroke expert.<br>Patient assessed by stroke specialist and has investigations completed within 24 hours.<br>Medium risk: patients are seen promptly in nearest stroke prevention clinic (within 3 days)<br>Low-risk: patients seen soon in nearest stroke prevention clinic (within 2 weeks)<br>Unsure: based on advice of stroke specialist | No details provided  |
| Ranta <i>et al</i> <sup>67</sup>       | Primary care<br>Internet-based clinical decision support tool  | GP uses decision support tool; single page of tick boxes covering   | Software confirms or rejects TIA/stroke diagnosis based on data entered by GP.  | Software offers GP two options:   | 1. Software generates referral form for TIA outpatient clinic with |

Continued



Table 3 Continued

| Study                            | Setting and intervention | Assessment and recognition of TIA   | Criteria for referral pathway (inclusion/exclusion criteria)   | Referral process   | Management or treatment   |
|----------------------------------|--------------------------|---|--|--|---|
| Ranta <i>et al</i> <sup>58</sup> |                          | background and clinical presentation data including:<br>Onset time, speed and resolution<br>Symptoms including unilateral weakness, unilateral numbness, visual symptoms, communication problems, posterior circulation symptoms, other symptoms<br>Vascular risk factors<br>Other risk factors<br>Examination data | Triage recommendation is generated based on ABCD2 score supplemented by variables from the New Zealand TIA guidelines.<br>Patients with low-risk scores are suitable for outpatient referral pathway. Software instructs GP to refer high-risk patient for same day specialist assessment via ED referral. | 1. Refer to TIA clinic for specialist review within 7 days<br>2. GP manages patient in the community | information for specialists to prioritise appropriately.<br>2. Software generates stepped process for GP to manage the patient in the community: covers relevant prescriptions, radiology referral and provision of patient information leaflets. |

AF, atrial fibrillation; ED, emergency department; GP, general practitioner; ICD, International Classification of Diseases; LDL, low-density lipoprotein; M3T, Monash TIA Triage Treatment; TIA, transient ischaemic attack.

Four studies<sup>52 51 56 57</sup> described the training and implementation processes provided to family doctors to support TIA referral pathways. These involved information leaflets about TIA and the referral pathways, distributed before and during the studies. Ranta *et al*<sup>57</sup> provided GP training on TIA and stroke management. Jeerakathil *et al*<sup>56</sup> also reported that an education strategy, for doctors and the general public, was undertaken. Training and implementation processes are described in table 4.

### Processes and outcomes

Six studies<sup>51–55 58</sup> reported stroke rates at 90 days, varying from 1.2% (n=13)<sup>52</sup> and (n=2)<sup>58</sup> to 2.1% (n=6).<sup>6</sup> Montassier *et al*<sup>53</sup> also reported that three TIAs occurred, representing 5% of low-risk patients with TIA referred to stroke clinic by emergency physicians. In that study, the confirmed stroke rate was 1.7% whereas predicted stroke rates at 90 days (predicted using the ABCD2 tool) was 9.7%. Lavallée *et al*<sup>52</sup> identified the predicted stroke rate of all presenting patients as 6% compared with the actual figure of 1.2%. Four studies<sup>6 52–54</sup> reported that between 44% and 82.6% of suspected low-risk patients with TIA were referred through the pathways designed to avoid hospital admission. Ranta *et al*<sup>58</sup> reported that 76% of patients managed by GPs using the decision support tool received management consistent with national guidelines compared with 41% of patients managed by GPs who did not have access to the tool. Outcomes are reported in table 5.

Kerr *et al*<sup>51</sup> reported that delays in clinic assessment and carotid surgery for patients with TIA reduced significantly ( $p<0.01$ ) after the introduction of their hotline—from 58 days before (range 6–135) to 21.5 days after (range 5–82). Two-thirds (67%: n=248) of cases referred using their hotline were seen by a specialist within 24 hours; most cases (94%: n=347) were seen by a specialist within 96 hours. Of the 88% of GPs surveyed about the pathway, 94% were ‘very satisfied’ with the process; no specialist described any critical incident because the hotline call disrupted their activity. No other studies reported these data.

Sanders *et al*<sup>54</sup> and Rothwell *et al*<sup>6</sup> reported the difference in stroke risk before and after the implementation of their pathway (at 90 days). For patients with confirmed TIA, Sanders *et al*<sup>54</sup> found a 3.78% (95% CI –0.19% to 9.89%) reduction in stroke risk following implementation of their pathway—from 5.84% before (95% CI 3.1% to 10.73%) to 1.74% after (95% CI 0.88% to 3.39%). Rothwell *et al*<sup>6</sup> provided an adjusted HR for stroke risk following implementation of their pathway of 0.20 (95% CI 0.8 to 0.49;  $p=0.0001$ ). Stroke risk was reportedly 10.3% before pathway implementation compared with 2.1% after ( $p=0.001$ ).

Ranta *et al*<sup>58</sup> reported economic analysis favouring the use of electronic decision support by GPs to triage patients with suspected TIA and stroke with a treatment

**Table 4** Referral pathway implementation processes

| Study                                  | Setting      | Implementation process, including training and educational materials   |
|--|--------------|--|
| Sanders <i>et al</i> <sup>54</sup>     | ED           | No details reported  |
| Montassier <i>et al</i> <sup>53</sup>  | ED           | No details reported  |
| Griffiths <i>et al</i> <sup>55</sup>   | ED           | No details reported  |
| Lavallee <i>et al</i> <sup>52</sup>    | Primary care | Leaflet on TIA emailed to family doctors, cardiologists, neurologists, ophthalmologists and EDs with information on definition, key symptoms, risks, main causes and emergency treatment of TIA emphasising opportunity to prevent potentially devastating stroke. Leaflet also advised of TIA clinic and free hotline phone number.   |
| Rothwell <i>et al</i> <sup>6</sup>     | Primary care | No details reported  |
| Kerr <i>et al</i> <sup>51</sup>        | Primary care | All GPs in area were sent written guidelines and hotline telephone number by email and post twice, 6 months apart<br>Reminder about service on footnote of every subsequent letter to GPs  |
| Jeerakathil <i>et al</i> <sup>56</sup> | Primary care | Pocket cards and PDF documents distributed province wide<br>Presentations given<br>Education modules about TIA management and slide sets created<br>TIA triaging algorithm adopted as TIA education strategy by province stroke strategy with materials on website<br>Knowledge of protocol shared with staff involved in care of patients who suffered stroke; communication with all stroke prevention clinics<br>Public education campaign about signs and symptoms of stroke |
| Ranta <i>et al</i> <sup>57</sup>       | Primary care | All study GPs were invited to an education session reviewing management of TIA and stroke, also with a briefing about study processes. Posters were displayed in study practices advising patients of the trial.   |
| Ranta <i>et al</i> <sup>58</sup>       |              |  |

ED, emergency department; GP, general practitioner; TIA, transient ischaemic attack.

**Table 5** Outcomes

| Study                                 | n/N (%) of patients with suspected low-risk TIA entering referral pathway | 90-day stroke rate n/N (%)                          | Unadjusted OR (95% CI) p     | Adjusted HR (95% CI) p                                  |
|---------------------------------------|---|---|------------------------------|---|
| Sanders <i>et al</i> <sup>54</sup>    | 301/488 (83)  | 7/468 (1.5) intervention<br>7/150 (4.67) control    | 3.78 (−0.19 to 9.89)         | 0.43 (0.12 to 1.59) 0.21                                |
| Montassier <i>et al</i> <sup>53</sup> | 62/118 (52)   | 1 (1.7) stroke<br>3 (5) TIA                         | Not reported                 | Not reported  |
| Griffiths <i>et al</i> <sup>55</sup>  | Not reported  | 3/200 (1.5)   | Not reported                 | Not reported  |
| Lavallee <i>et al</i> <sup>52</sup>   | 808/1085 (74)   | Not reported  | Not reported                 | Not reported  |
| Rothwell <i>et al</i> <sup>6</sup>    | 281/644 (44)  | 6/281 (2.1)   | Not reported                 | 0.20 (0.08 to 0.49); 0.0001                             |
| Ranta <i>et al</i> <sup>58</sup>      | 172/291 (59)  | 2/172 (1.2) (intervention)<br>5/119 (4.2) (control) | 0.27 (0.05 to 1.41)<br>0.098 | Not possible to calculate due to small number of events |

TIA, transient ischaemic attack.

cost ratio of 0.65 (95% CI 0.47 to 0.91,  $p=0.013$ ). No increased adverse events were recorded. Clinician feedback was positive.

Other results provided by the included studies may be of use in developing our intervention. For example, Griffiths *et al*<sup>55</sup> reported that some included patients were found to have a diagnosis other than TIA, including migraine, presyncope, Bell's palsy and seizure with TIA-mimicking symptoms. Sanders *et al*<sup>54</sup> reported that there were no significant differences in stroke outcome between patients who were admitted ( $n2/N85$ ; 2.35%) and patients who were not admitted ( $n5/N4.3$ ; 1.24%). Lavallee *et al*<sup>52</sup> found that 74% ( $n=808$ ) of their included patients did not require admission following examination at their 24-hour access clinic.

## DISCUSSION

### Summary of findings

We identified nine international papers reporting eight studies which described pathways to refer patients with suspected TIA for specialist evaluation. In all cases, pre-hospital decisions about patient care were made by physicians. We identified five pathways which were delivered in primary care, where family doctors identified and referred patients with suspected TIA through an electronic decision support tool, a consultant-led telephone service or directly to clinic. In three studies, ED physicians assessed and referred suitable patients to prevent hospital admission. Outcome data suggested that numbers experiencing another stroke or TIA within 90 days were reduced in patients treated through these

pathways. Our literature review did not reveal any pathways used by paramedics. There was limited comparative evidence about effects of these pathways on patient outcomes. Only one study used a randomised controlled design and others were limited by not having a controlled comparator group. Two of the included papers were protocols and no results were reported for one of these. Findings should be treated cautiously, although the pathways did not appear to negatively affect patient safety.

### Strengths and limitations

We followed a systematic approach based on guidance for carrying out a scoping review and reported our methods fully in line with guidance.<sup>38 44</sup>

Two researchers had carried out the search and screening stages. We did not undertake a full systematic review since our objective was to inform intervention development in our feasibility study and we were concerned about timescales as experienced by other authors.<sup>45</sup> We therefore took a pragmatic decision to balance thoroughness and transparency while delivering timely scoping review results in order to inform development of intervention and implementation of our trial. We also discussed methods and findings within the study team to assess and monitor processes.

We did not assess reporting quality of papers and chose to include all study designs in order to search widely across the research literature.<sup>38 41</sup> However, all papers were published in international peer-reviewed journals and we have reported study results to aid interpretation, in line with recommendations.<sup>38</sup>

### Implications for practice and research

Suspected TIA is common; identification and appropriate referral may be an opportunity to prevent subsequent stroke.<sup>2-5</sup> Timely access to specialist evaluation is therefore important, particularly since two out of three cases diagnosed in hospital can be missed and onward referrals from hospital to specialist services are often delayed.<sup>13 59</sup>

This review extends the findings of Ranta and Barber<sup>60</sup> by describing an additional four prehospital pathways for patients with TIA. In this study, we have identified features of referral pathways which safely avoided the need for patients with low risk of further TIA or stroke to be admitted to hospital. Physicians used a decision tool to assess and triage patients—software, algorithms or checklists—although stroke physicians also had direct input to the pathway by contributing to triage decisions, particularly within primary care. Using the decision tool, physicians followed predefined steps to communicate patient details directly to a specialist or central point where specialist review would be arranged. Antiplatelet therapy was prescribed (usually aspirin) unless contraindicated. These pathways were used by family doctors and ED physicians but there is no evidence of use by paramedics.

The decision tools ranged from a simple yes/no checklist of five questions to a computer-based algorithm incorporating real-time and historic data to offer referral options. In New Zealand, Ranta *et al*<sup>58</sup> reported that electronic decision assistance systems reduced unnecessary ED and neurospecialist investigation. Meanwhile a UK-tested hospital online system has stratified and speedily referred patients with TIA for clinical assessment with no patients receiving wrong risk scores.<sup>61</sup>

Our findings contribute evidence to support using a risk assessment procedure to aid clinical assessment in the prehospital environment with the potential to extend pathways for patients experiencing less urgent conditions to avoid hospital admission.<sup>18-27</sup> Correct diagnosis of TIA and assessment of risk of future events is recognised to be challenging, since symptoms are temporary and mimic other, often common, conditions.<sup>12 14</sup> However, several studies described using the ABCD2 tool to assess risk of further TIA or stroke, without reported difficulties. This suggests the tool can be used to assess and triage patients presenting in the community before onward referral. The Royal College of Physicians identified that paramedics need to be able to identify stroke and TIA cases and called for *further research to validate safe and appropriate care pathways* (p. 61)<sup>14</sup> in the prehospital setting. Decision support tools contribute evidence to enhance risk assessment procedures and support clinical appraisal. Although paramedics are risk averse and want a process to ‘cover our backs’,<sup>62</sup> computerised clinical decision support has enabled them to refer twice as many patients to appropriate treatment in place of hospital conveyance, with potential cost-savings. However, paramedics’ use of electronic processes is not widespread.<sup>20</sup> Our findings show that simple checklists, algorithms and computer-based automatic population and calculation features of computerised systems are all feasible and safe in the prehospital setting.

The lack of evidence about paramedic referral pathways highlights the need for further research. The safety and acceptability of referral pathways, to patients and to providers and commissioners of healthcare, is not known nor their effect on resource usage. We identified three questions for immediate investigation, in order to understand the feasibility, safety and effects of prehospital referral of patients with suspected TIA:

- ▶ Can paramedics safely identify patients with suspected TIA and assess risk of further TIA or stroke?
- ▶ Do prehospital referral pathways enable patients to see specialist clinicians in a timely way?
- ▶ How do prehospital referral pathways affect patients’ experience, treatment and outcomes?

### CONCLUSION

The scoping method allowed us to identify and describe existing knowledge about referral of patients with TIA to avoid hospital admission. This has shown that there is

limited evidence describing pathways delivered by family doctors or emergency care physicians and none for paramedics. The identified pathways used checklists to diagnose TIA and identify patients for onward transport or admission to hospital or direct referral to a specialist stroke clinic. Referral arrangements were communicated by fax or telephone hotline and patients received bespoke information and interim medication such as aspirin before being left at home.

The absence of evidence about paramedic referral pathways underlines the need for research into safe and effective processes to optimise treatment of patients with TIA and reduce the burden on hospitals and EDs. Our research team includes paramedics, ambulance services managers, nurses, stroke clinicians and patients alongside experienced trialists. We have used findings from this review alongside results from a survey of UK ambulance services and clinical and operational expertise from stroke, ED and prehospital practitioners, to develop and test a referral pathway protocol for paramedics to use when responding to patients with suspected TIA. We will investigate the feasibility of applying and evaluating this pathway to assess whether it can be delivered by paramedics and is safe and acceptable for patients, in order to plan a fully powered multicentre randomised trial if indicated.

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## REFERENCES

- Albers GW, Caplan LR, Easton JD, *et al.* Transient ischemic attack—proposal for a new definition. *N Engl J Med* 2002;347:1713–16.
- Kleindorfer D, Panagos P, Pancioli A, *et al.* Incidence and short-term prognosis of transient ischemic attack in a population-based study. *Stroke* 2005;36:720–3.
- Coull AJ, Lovett JK, Rothwell PM. Population based study of early risk of stroke after transient ischaemic attack or minor stroke: implications for public education and organisation of services. *BMJ* 2004;328:326.
- Johnston SC, Gress DR, Browner WS, *et al.* Short-term prognosis after emergency department diagnosis of TIA. *JAMA* 2000;284:2901–6.
- Olson DM, Cox M, Pan W, *et al.* Death and rehospitalization after transient ischemic attack or acute ischemic stroke: one-year outcomes from the adherence evaluation of acute ischemic stroke-longitudinal registry. *J Stroke Cerebrovasc Dis* 2013;22:e181–8.
- Rothwell PM, Giles MF, Chandratheva A, *et al.* Effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (EXPRESS study): a prospective population-based sequential comparison. *Lancet* 2007;370:1432–42.
- Department of Health. Reducing Brain Damage: Faster access to better stroke care. 2005. <http://www.nao.org.uk/wpcontent/uploads/2005/11/0506452.pdf> (accessed 20 Feb 2015).
- Castledine G, Close A. Stroke and transient ischaemic attack: an overview. In: Castledine G, Close A, eds. *Oxford Handbook of Adult Nursing*. Oxford: Oxford University Press, 2009:46–7.
- Sprigg N, Machili C, Otter ME, *et al.* A systematic review of delays in seeking medical attention after transient ischaemic attack. *J Neurol Neurosurg Psychiatry* 2009;80:871–5.
- Wilson AD, Coleby D, Regen E, *et al.* Service factors causing delay in specialist assessment for transient ischaemic attack and minor stroke: a qualitative study of GP and patient perspectives. *BMJ Open* 2016;6:e011654.
- Johnston SC, Rothwell PM, Huynh-Huynh MN, *et al.* Validation and refinement of scores to predict very early stroke risk after transient ischemic attack. *Lancet* 2007;369:283–92.
- National Institute for Clinical Excellence. NICE clinical guideline 68 Stroke: diagnosis and initial management of acute stroke and transient ischaemic attack (TIA). 2008. <http://www.nice.org.uk/nicemedia/pdf/CG68NICEGuideline.pdf> (accessed 20 Feb 2015).
- Sales M, Quain D, Lasserson D, *et al.* Quality of referrals and guideline compliance for time to consultation at an acute neurovascular clinic. *J Stroke Cerebrovasc Dis* 2015;24:874–80.
- Intercollegiate Stroke Working Party. National clinical guideline for stroke. London. 2012. <http://www.rcplondon.ac.uk/sites/default/files/nationalclinical-guidelines-for-stroke-fourth-edition.pdf> (accessed 20 Feb 2015).
- Omar A, Penglass RG, Chen MS, *et al.* A retrospective analysis of inpatient compared to outpatient care for the management of patients with transient ischaemic attack. *J Clin Neurosci* 2013;20:988–92.
- Wasserman J, Perry J, Dowlatshahi D, *et al.* Stratified urgent care for transient ischemic attack results in low stroke rates. *Stroke* 2010;41:2601–5.
- Ben-Yakov M, Kapral MK, Fang J, *et al.* The Association between emergency department crowding and the disposition of patients with transient ischemic attack or minor stroke. *Acad Emerg Med* 2015;22:1145–54.
- NHS England. *Transforming urgent and emergency care services in England: improving referral pathways between urgent and emergency services in England*. London: NHS England, 2015.
- Snooks H, Anthony R, Chatters R, *et al.* Support and assessment for fall emergency referrals (SAFER 2) research protocol: cluster randomised trial of the clinical and cost effectiveness of new protocols for emergency ambulance paramedics to assess and refer to appropriate community-based care. *BMJ Open* 2012;2:pii: e002169.
- Snooks HA, Carter B, Dale J, *et al.* Support and assessment for fall emergency referrals (safer 1): cluster randomised trial of computerised clinical decision support for paramedics. *PLoS ONE* 2014;9:e106436.
- Halter M, Vernon S, Snooks H, *et al.* Complexity of the decision-making process of ambulance staff for assessment and referral of older people who have fallen: a qualitative study. *Emerg Med J* 2011;28:44–50.
- Dixon S, Mason S, Knowles E, *et al.* Is it cost effective to introduce paramedic practitioners for older people to the ambulance service? Results of a cluster randomised controlled trial. *Emerg Med J* 2009;26:446–51.
- O'Hara R, Johnson M, Siriwardena AN, *et al.* A qualitative study of systemic influences on paramedic decision making: care transitions and patient safety. *J Health Serv Res Policy* 2015;20(Suppl 1):45–53.
- Snooks H, Williams S, Crouch R, *et al.* NHS emergency response to 999 calls: alternatives for cases that are neither life threatening nor serious. *BMJ* 2002;325:330.
- Snooks H, Kearsley N, Dale J, *et al.* Towards primary care for non-serious 999 callers: results of a controlled study of "Treat and Refer" protocols for ambulance crews. *Qual Saf Health Care* 2004;13:435–43.



26. Snooks H, Foster T, Nicholl J. Results of an evaluation of the effectiveness of triage and direct transportation to minor injuries units by ambulance crews. *Emerg Med J* 2004;21:105–11.
27. Snooks H, Cheung WY, Close J, *et al.* Support and Assessment for Fall Emergency Referrals (SAFER 1) trial protocol. Computerised on-scene decision support for emergency ambulance staff to assess and plan care for older people who have fallen: evaluation of costs and benefits using a pragmatic cluster randomised trial. *BMC Emerg Med* 2010;10:2.
28. National Health Executive. Demand pressures affecting ambulance response times. 2014. <http://www.nationalhealthexecutive.com/Health-Care-News/demand-pressures-affecting-ambulance-response-times-> (accessed 25 Feb 2015).
29. BBC News. Firefighters step in to aid Oxfordshire ambulance demand. 2015 (Accessed 26 Feb 2015). <http://www.bbc.co.uk/news/uk-england-oxfordshire-30724426>
30. BBC News. Police say ambulance service putting demand on its resources. 2014 (accessed 26 Feb 2015). <http://www.bbc.co.uk/news/uk-england-essex-25669203>
31. Intercollegiate Stroke Working Party. *National clinical guideline for stroke*. 4th edn. London: Royal College of Physicians, 2016.
32. Rothwell PM, Giles MF, Flossmann E, *et al.* A simple score (ABCD) to identify individuals at high early risk of stroke after transient ischaemic attack. *Lancet* 2005;366:29–36.
33. Wardlaw J, Brazzelli M, Miranda H, *et al.* An assessment of the cost-effectiveness of magnetic resonance, including diffusion-weighted imaging, in patients with transient ischaemic attack and minor stroke: a systematic review, meta-analysis and economic evaluation. *Health Technol Assess* 2015;18:369–70.
34. Rae V, Ford G, Price C. Prehospital assessment of stroke: time is brain. *J Paramed Pract* 2011;3:483–8.
35. Mant J, Ryan R, McManus R, *et al.* *What is the optimum model of service delivery for transient ischaemic attack?* Report for the National Co-ordinating Centre for NHS Service Delivery and Organisation R&D (NCCSDO), April 2008.
36. Shanyinde M, Pickering RM, Weatherall M. Questions asked and answered in pilot and feasibility randomized controlled trials. *BMC Med Res Methodol* 2011;11:117.
37. Smith L, McCourt O, Henrich M, *et al.* Multiple myeloma and physical activity: a scoping review. *BMJ Open* 2015;5:e009576.
38. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8:19–32.
39. Anderson S, Allen P, Peckham S, *et al.* Asking the right questions: scoping studies in the commissioning of research on the organisation and delivery of health services. *Health Res Policy Syst* 2008;6:7.
40. Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J* 2009;26:91–108.
41. Hamm MP, Chisholm A, Shulhan J, *et al.* Social media use among patients and caregivers: a scoping review. *BMJ Open* 2013;3:e002819.
42. Zinszer K, Verma AD, Charland K, *et al.* A scoping review of malaria forecasting: past work and future directions. *BMJ Open* 2012;2:e001992.
43. Armstrong R, Hall BJ, Waters E. 'Scoping the scope' of a Cochrane review. *J Public Health* 2011;33:147–50.
44. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci* 2010;5:69.
45. Brien S, Lorenzetti D, Lewis S, *et al.* Overview of a formal scoping review on health system report cards. *Implement Sci* 2010;5:2–10.
46. Centre for Reviews and Dissemination. *Systematic reviews: CRD's guidance for undertaking reviews in healthcare*. York: CRD, 2001.
47. Daudt HML, van Mossel C, Scott SJ. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC Med Res Methodol* 2013;13:48.
48. Higgins JPT, Green S. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0* 2011: The Cochrane Collaboration.
49. Moher D, Alessandro L, Jennifer T, *et al.* Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA Statement. *PLoS Med* 2009;6:e1000097.
50. Ritchie J, Spencer L. Qualitative data analysis for applied policy research. In: Bryman A, Burgess RG. eds. *Analysing qualitative data*. London: Routledge, 1994:173–94.
51. Kerr E, Arulraj N, Scott M, *et al.* A telephone hotline for transient ischaemic attack and stroke: prospective audit of a model to improve rapid access to specialist stroke care. *BMJ* 2010;341:c3265.
52. Lavallée PC, Meseguer E, Abboud H, *et al.* A transient ischaemic attack clinic with round-the-clock access (SOS-TIA): feasibility and effects. *Lancet Neurol* 2007;6:953–60.
53. Montassier E, Lim T-X, Goffinet N, *et al.* Results of an outpatient transient ischemic attack evaluation: a 90 day follow-up study. *J Emerg Med* 2013;44:970–5.
54. Sanders LM, Srikanth VK, Jolley DJ, *et al.* Monash transient ischemic attack triaging treatment safety of a transient ischemic attack mechanism-based outpatient model of care. *Stroke* 2012;43:2936–41.
55. Griffiths D, Sturm J, Heard R, *et al.* Can lower risk patients presenting with transient ischaemic attack be safely managed as outpatients? *J Clin Neurosci* 2014;21:47–50.
56. Jeerakathil T, Shuaib A, Majumdar SR, *et al.* for the ASPIRE Investigators. The Alberta Stroke Prevention in TIAs and mild strokes (ASPIRE) intervention: rationale and design for evaluating the implementation of a province-wide TIA Triaging system. *Int J Stroke* 2012;9:135–43.
57. Ranta A, Dovey S, Weatherall D, *et al.* Efficacy and safety of a TIA/stroke electronic support tool (FASTEST) trial: study protocol. *Implement Sci* 2012;7:107.
58. Ranta A, Dovey S, Weatherall M, *et al.* Cluster randomised controlled trial of TIA electronic decision support in primary care. *Neurology* 2015;84:1545–51.
59. Tu K, Wang M, Young J, *et al.* Validity of administrative data for identifying patients who have had a stroke or transient ischemic attack using EMRALD as a reference standard. *Can J Cardiol* 2013;29:1288–394.
60. Ranta A, Barber PA. Transient ischemic attack service provision. *Neurology* 2016;86:947–53.
61. Guvler PC, Lognathan T, Ude S, *et al.* An innovative online system to risk-stratify and directly refer TIA patients: HOT-TIA. *Int J Stroke* 2013;8(Suppl 3):38.
62. Porter A, Snooks H, Youren A, *et al.* "Covering our backs": ambulance crews' attitudes towards clinical documentation when emergency (999) patients are not conveyed to hospital. *Emerg Med J* 2008;25:292–29.